

Lecture 1

Embedded System

Raspberry Pi & Arduino

物聯網

Internet of Things

- 不同的裝置透過網際網路，達到物物相連的目的
- 技術內涵：感測器、資料傳輸、數據分析、...

AIoT = AI + IoT

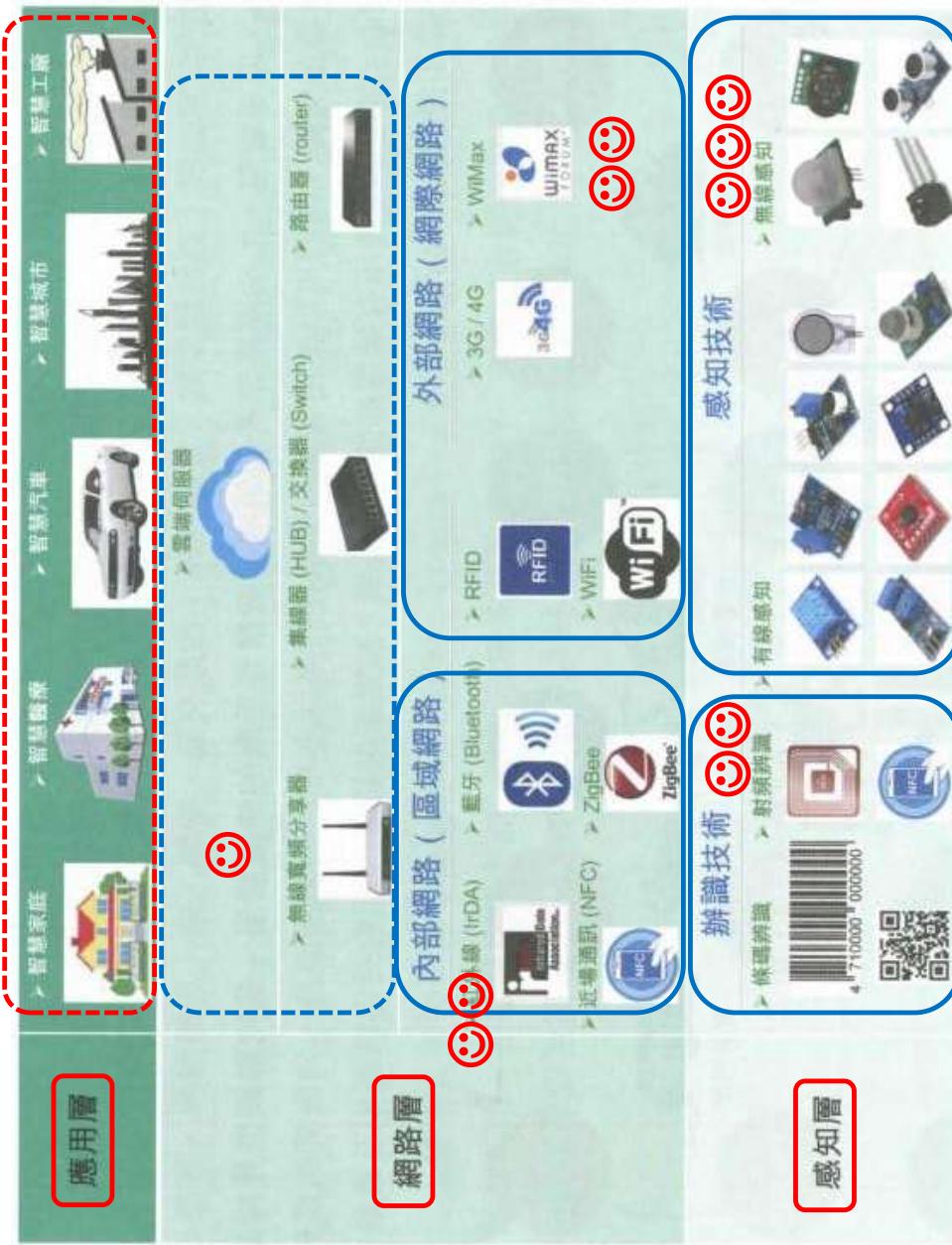
人工智慧與物聯網

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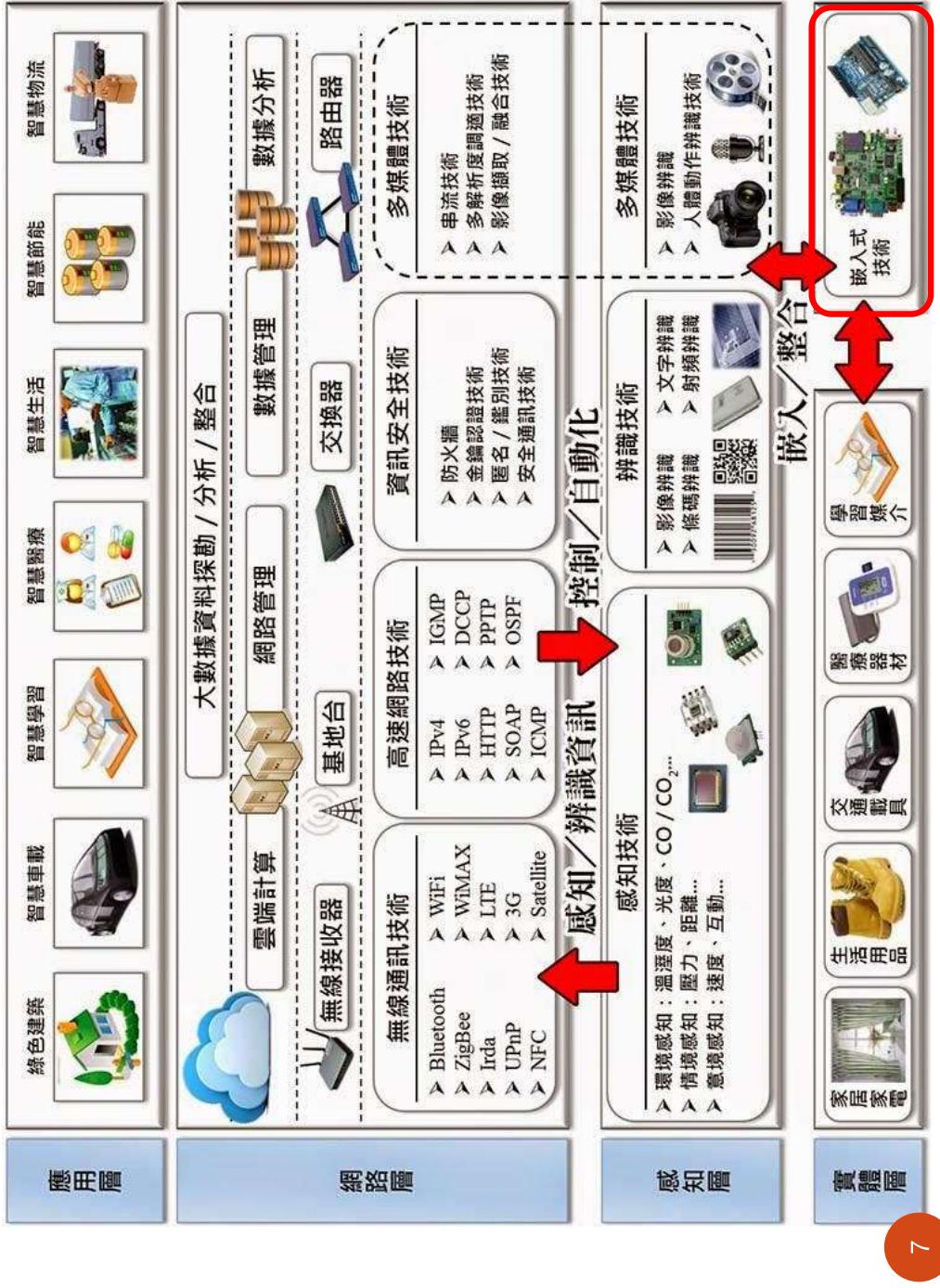
4

<https://www.youtube.com/watch?v=LE0EB9qDXnU&t=22s>



IoT Architecture (架構)

- **Perception layer (感知層)**
 - Acquire and process the data from the real world
- **Network layer (網路層)**
 - Data transmission
- **Application layer (應用層)**
 - Data processing and service providing



Topics

- **Embedded systems**
 - Raspberry Pi, Arduino
- **Sensors**
 - RFID, temperature, distance, CO₂, PM2.5, PH, ...
 - I2C, TCP/IP, ...
- **Networks**
 - Bluetooth, WiFi, Zigbee, NFC, 3G/4G/5G, ...
 - IPv4/IPv6, HTTP, SOAP, ...
- **Cloud service**
 - SaaS, PaaS, IaaS, ...
- **Data analysis**
 - Machine learning

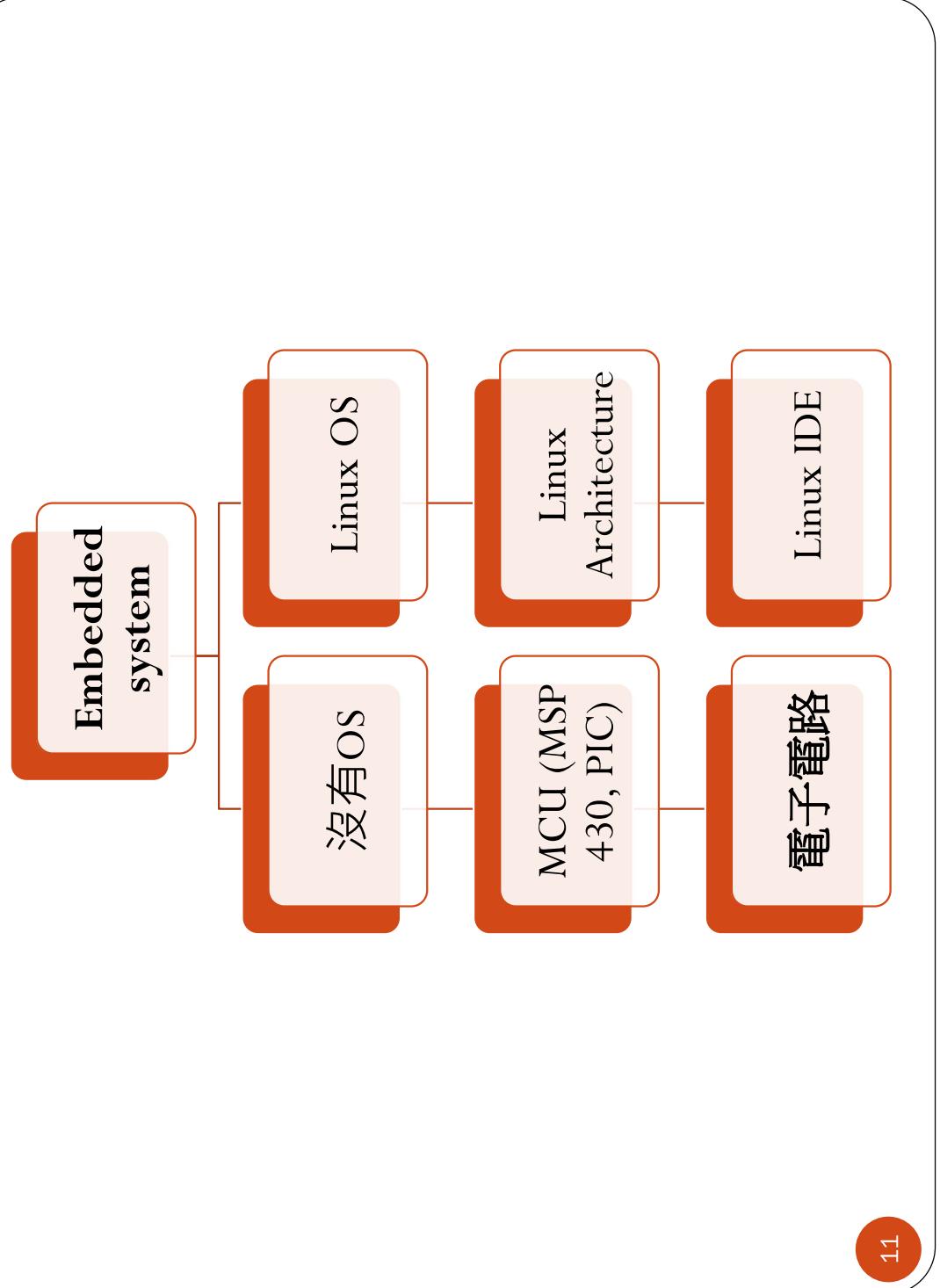
嵌入式系統 (Embedded System)

- 嵌入式系統是包含了CPU、記憶體、I/O周邊的電腦系統，且具備以下特性：**(from IEEE)**
 - 通常用來執行某個**特定功能**
 - 通常以**微電腦與周邊構成核心**
 - **嚴格的時序與穩定度要求**。
 - **全自動操作循環**

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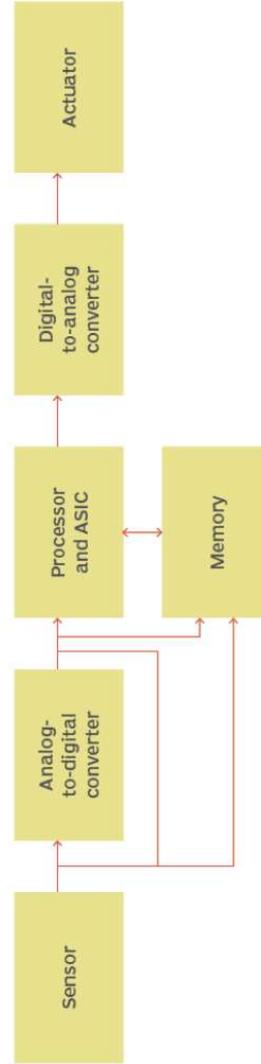
- **Key characteristics of embedded systems:**
 - Dedicated Functionality
 - Real-time Operation
 - Resource Constraints
 - Reliability
 - Low Power Consumption
- Embedded systems typically consist of both **hardware** and **software** components
 - The hardware includes microcontrollers or microprocessors, sensors, actuators, memory, and various interfaces.
 - The software includes the operating system (if applicable), device drivers, middleware, and application software.

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- Embedded system and **Embedded OS**
- An embedded OS is a specialized operating system designed to perform a specific task for a device that is not a computer.
- An embedded OS must be reliable and able to run with constraints on memory and processing power.
- Example
- Cellphone: Android, iOS

Embedded system structure diagram



Embedded System Solutions: **MANY!**

Why Arduino + Raspberry Pi ?

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How the Raspberry Pi Works



BY BERNADETTE JOHNSON

Why Choose the Raspberry Pi and Not Something Else?

The Raspberry Pi has a few competitors, although the foundation encourages people to clone its idea, so competitor might not be the right word. They include BeagleBoard and PandaBoard (which are both the names of the companies and their main devices). Both are nonprofit organizations but with slightly different goals than the Raspberry Pi Foundation. **BeagleBoard** is geared toward adult hardware tinkerers, and **PandaBoard** aims to make a mobile software-programming platform available at a reasonable price.

Like Raspberry Pi, they're both exposed boards with ARM processors and are HD video capable. But BeagleBoards and PandaBoards have more connectors and connection headers (bits of the board that can be used by soldering additional hardware) than the Raspberry Pi, and both devices are a bit larger. The following aren't exhaustive lists of components, but here are some features that differ from the Pi:

<https://computer.howstuffworks.com/raspberry-pi4.htm>

[« PREV](#) [NEXT »](#)

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For its intended educational purposes, the Raspberry Pi has two major advantages over the others. First, it was conceived to be a complete working computer. You simply need to insert an SD card containing the OS, connect the peripherals and power, and it's ready to go. BeagleBoards and PandaBoards require hookup to a host computer for initial setup, and though they have similar processing capabilities, they take a little more know-how to get them fully functional.

Second, the other devices are much more expensive than the Raspberry Pi. For example, in April 2012, the pricing was \$125 to \$149 for the two main BeagleBoard models, and \$174 to \$182 each for the two PandaBoard models. These prices are a far cry from the \$25 and \$35 base prices of the Raspberry Pi. This doesn't mean that the other devices aren't for you. You just have to examine the specs and determine which machine best suits your needs. Given its functionality and price, the Raspberry Pi seems better poised to get computing power to the masses.

Hardware aside, software-based educational resources are available for anyone wishing to learn programming on current computers.

樹莓派：功能完整、使用簡單、價格便宜

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The page shows a navigation bar with links to HOME, ARDUINO, POPULAR POSTS, and WHY CHOOSE ARDUINO? Below the navigation bar, there are two columns of content. The left column features a section titled "History of ARDUINO" with a small image of a hand holding a breadboard. The right column features a section titled "Why Choose ARDUINO?" with a small image of a breadboard. Both sections contain descriptive text about the history and benefits of using Arduino for physical computing.

<http://creativityprojects.blogspot.com/2013/03/why-choose-arduino.html>

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Arduino

相較於其他微控制器開發板，Arduino具備以下優點：

- 跨平台
 - 相容於Mac, Windows, Linux等作業系統
 - 使用簡單
 - 模組擴充容易及簡便的軟體編輯環境
- 軟硬體開源
- 價格便宜

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Raspberry Pi 樹莓派周邊控制和物聯網 Dashboard實作(110.04.26與05.03)



回到訊息

線上報名

工研院同仁報名

加入收藏清單

我要留言

https://college.itri.org.tw/all-events-2/646B52C9-0925-40BA-B7FF-4E1F703C5685.html?utm_medium=crssearch&utm_source=college

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企業訓練類別	專業訓練課程
課程名稱	<u>Arduino EPS32 機械手臂暨智慧物聯網應用班【產業人才投資計畫】</u>
報名截止日期	2021-06-29
開課日期	2021-06-29
課程目的	實作機械手臂運用及智慧物聯網、無人化工廠機器手臂實作，以逐步示範的方式進行實作，進而快速學會設計要領，對於指令精確的講解，提高學員在社會上專業領域之競爭力。
課程主旨	

7/10 (上午) IoT物聯網應用概念:

1.物聯網介紹 2.物聯網應用及智慧生活趨勢 3.Arduino C 變數[介紹 4.開發環境認識及建置 5.Arduino與C語言應用及介紹

7/10 (下午) 基本語法與結構控制: 1.Arduino C 判斷式及if ..else 使用 2.switch運用及介紹 3.認識判斷式與執行 4.

https://www.thiu.org.tw/class_detail.php?id=1555

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班別資料

課程代碼：	146909
課程名稱：	<u>人工智慧與物聯網(AIoT)進階(假日班)(泰山)第01期</u>
訓練單位：	勞動力發展署北基宜花金馬分署

課程內容

訓練職類：	電子及電子通訊工程技術
緣由：	配合政府推展國內本土產業的優勢及新技術發展趨勢，以培養具理論與實務能力之人工智慧與物聯網應用平台串聯各種智慧應用領域技術人才，並著重實務訓練，以符合新一波的產業革命與商機之人力需求，以提昇個人的智慧商務新概念。
訓練目標：	用 RaspberryPi + Arduino 瞭解物聯網、學習人工智慧常用的工具軟體、明瞭目前 AI 熱門框架的特性，以具備操作 AI 的能力並能運用於物聯網。 備註：樹莓派 RaspberryPi 須由學員們自備
就業展望：	提升個人AI與物聯網應用技術能力，並拓展至工作及生活領域中。

<https://ojt.wda.gov.tw/ClassSearch/Detail?PlanType=2&OCID=146909>

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Training

Our training introduces IoT from the beginners level to the in-depth, advanced concepts and design methodologies to develop IoT applications, languages and tools optimized for IoT domain. It also exposes the students to the basic networking concepts along with an insight into newly developed IoT-specific application and physical layer protocols.

Why Choose this Course?

Xantra offers one of the best IoT Training course . This is the first such IoT training course Launched in North East. This is a class room based course which can give you a real head start of within 6 months in IoT and put you on track to achieving greater success in your career. It is estimated that billions of devices will be out there making an impact on Trillions of dollars of economy.

<http://xantra.in/training.html>

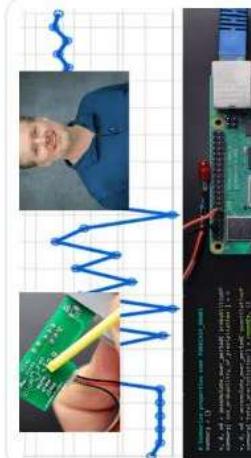
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Get ready for the next smart decade.

REGISTER NOW

Arduino, Raspberry Pi, Android App, Web service and Database, ...

coursera



Johns Hopkins University

Raspberry Pi Projects

Skills you'll gain: Hardware Design, Electronic Hardware, Schematic Diagrams, Computer-Aided Design, Mechanical Design, Remote Access...

4.9 · 75 reviews
Beginner · Specialization · 3 - 6 Months

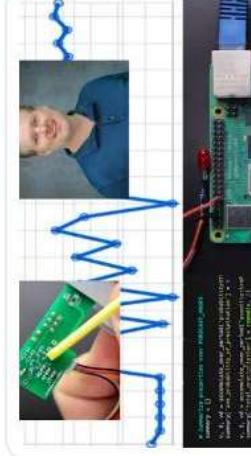


University of California, Irvine

The Raspberry Pi Platform and Python Programming for the Raspberry Pi

Skills you'll gain: Linux, Operating Systems, Integrated Development Environments, File Systems, Internet Of Things, Command-Line...

4.7 · 2.8K reviews
Mixed · Course · 1 - 4 Weeks



Johns Hopkins University

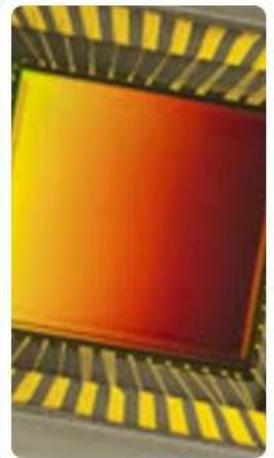
Beginning Custom Projects with Raspberry Pi

Skills you'll gain: Remote Access Systems, Linux, Web Applications, Internet Of Things, Embedded Systems, Application Programming Interface...

4.9 · 39 reviews
Mixed · Course · 1 - 4 Weeks

<https://www.coursera.org/courses?query=raspberry%20pi>

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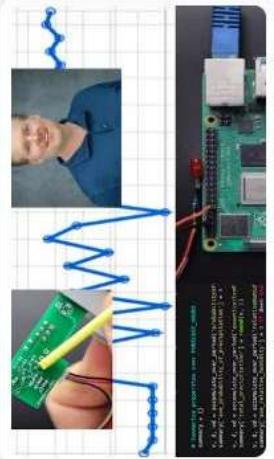
uci University of California, Irvine

Interfacing with the Raspberry Pi

Skills you'll gain: Internet Of Things, Application Programming Interface (API), TCP/IP, Embedded Systems, Network Protocols, USB, General...

4.7 · 1.6K reviews
Mixed · Course · 1 - 4 Weeks

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uci Johns Hopkins University

Using Sensors With Your Raspberry Pi

Skills you'll gain: Test Planning, Embedded Systems, Linux, Internet Of Things, Embedded Software, Functional Requirement, Debugging,...

4.7 · 20K reviews
Beginner · Specialization · 3 - 6 Months



uci University of California, Irvine

An Introduction to Programming the Internet of Things (IOT)

Skills you'll gain: Test Planning, Embedded Systems, Linux, Internet Of Things, Embedded Software, Functional Requirement, Debugging,...

4.7 · 20K reviews
Beginner · Specialization · 3 - 6 Months

Design, create, and deploy a fun IoT device using Arduino and Raspberry Pi platforms.

This Specialization covers embedded systems, the Raspberry Pi Platform, and the Arduino environment for building devices that can control the physical world. In the final Capstone Project, you'll apply the skills you learned by designing, building, and testing a microcontroller-based embedded system, producing a unique final project suitable for showcasing to future employers. Please note that this specialization does not offer discussion forums.

所有 指導項

"raspberry pi"共返回 17 條結果

學生職業成果

50% 完成此 專項課程 後開始了新的職業。

uci University of California, Irvine

20% 加薪或升職。

An Introduction to Programming the Internet of Things (IOT)

專項課程

★★★☆☆ 4.6 (16,474) | 400K 名學生

Beginner

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IT 與軟體 > 硬體 > Raspberry Pi

Raspberry Pi Bootcamp : For the Beginner

Learn about the Raspberry Pi, build a DIY Google Home Clone, RetroPie Gaming System, work with GPIO pins and much more..

4.1 ★★★★☆ (630 個評等), 4085 位學生

建立者 : Lee Assam

上次更新 2/2022 英語 英語 [自動], 印尼文 [自動], 還有 4 種語言

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IT & Software > Hardware > Raspberry Pi



Preview this course

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The Ultimate Guide to IoT with Raspberry Pi and Python -2024

Hands-On Raspberry Pi Projects: Unleash Your Creativity with Python, Linux, GPIO, Thingspeak, AWS IoT Core, IFTTT, Twilio

<https://www.udemy.com/course/internet-of-things-using-raspberry-pi-and-python-2023/>

Summary

- **Raspberry Pi** offers a more powerful computing platform with features like multimedia support and networking capabilities;
- **Arduino** provides a simpler, real-time embedded platform ideal for projects requiring sensor interfacing and physical computing tasks.
- The choice between Raspberry Pi and Arduino depends on the specific requirements and constraints of your project.

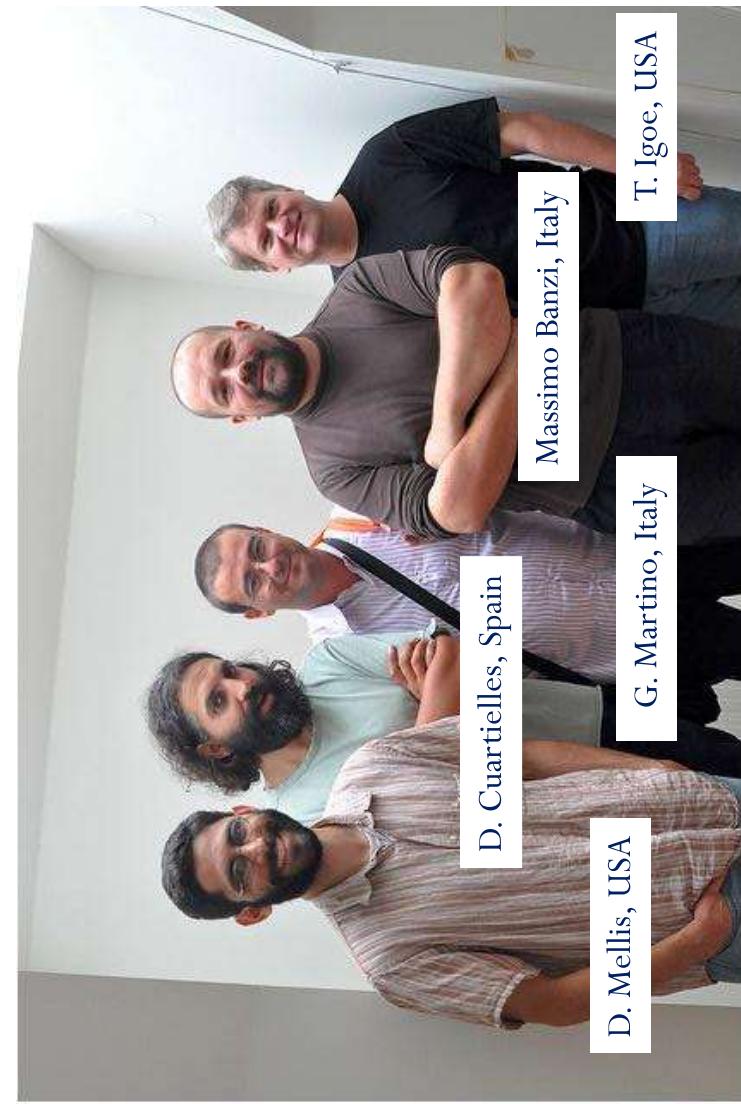
Ready for the A + R ?

Embedded System

- Arduino
 - DIO, Analog in,
 - Single-board **microcontroller**
- Raspberry Pi
 - Communication to database, cloud,
 - Single-board **computer**

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Arduino



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Arduino 是如何打開想像力的

2,213,219 plays ⏱ | Massimo Banzi | TEDGlobal 2012 • June 2012

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- Arduino features
 - Free Arduino software (IDE)
 - Windows, Mac, Linux
 - C/C++, Python
 - Open-source hardware
 - Low price
 - Atmel AVR
 - USB interface
 - Easy to use



<https://www.arduino.cc/>

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Arduino IDE 2.3.4

DOWNLOAD OPTIONS

Windows Win 10 and newer, 64 bits

Windows MSI installer

Windows ZIP file

Linux AppImage 64 bits (X86-64)

Linux ZIP file 64 bits (X86-64)

macOS Intel, 10.15: "Catalina" or newer, 64 bits

macOS Apple Silicon, 11: "Big Sur" or newer, 64 bits

[Release Notes](#)

The new major release of the Arduino IDE is faster and even more powerful! In addition to a more modern editor and a more responsive interface it features autocompletion, code navigation, and even a live debugger.

For more details, please refer to the [Arduino IDE 2.0 documentation](#).

Nightly builds with the latest bugfixes are available through the section below.

SOURCE CODE

The Arduino IDE 2.0 is open source and its source code is hosted on [GitHub](#).

<https://www.arduino.cc/en/software>

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PROFESSIONAL	EDUCATION	STORE	HARDWARE	SOFTWARE	CLOUD	DOCUMENTATION	COMMUNITY ▾

[Back to Arduino Support](#)

Download and install Arduino IDE

Learn how to download and install the desktop-based Arduino IDE.

Installation instructions

ⓘ Note

If you're using a Chromebook, see [Use Arduino with Chromebook](#).

Windows

<https://support.arduino.cc/hc/en-us/articles/360019833020-Download-and-install-Arduino-IDE>

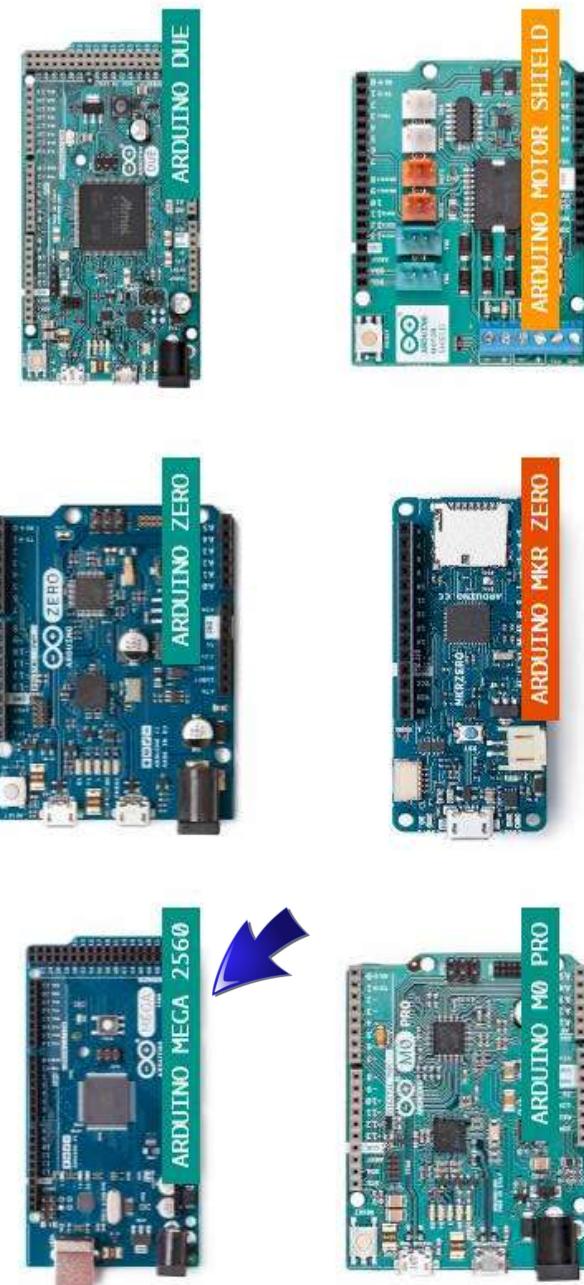
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Basics



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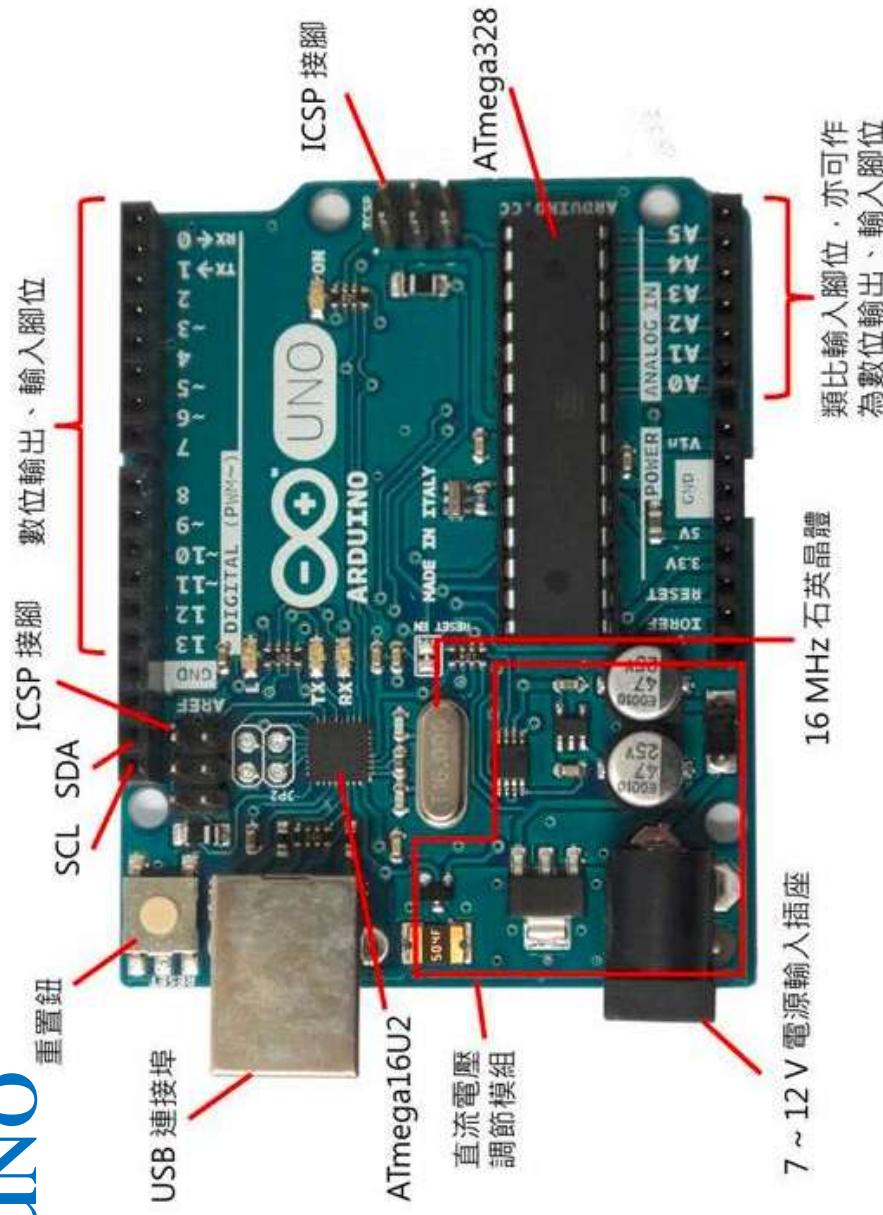
Advanced



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有更多的記憶體容量與IO腳位

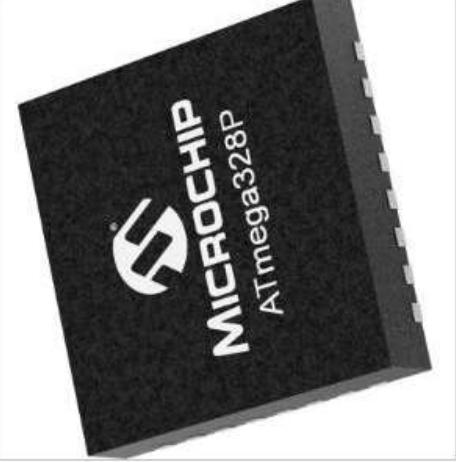
UNO



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- ICSP (在線串接燒錄)
- In Circuit Serial Programming
- SDA
- Serial Data Line
- Serial Clock Line
- I₂C (IC 之間的一種通訊協定)
- Inter-Integrated Circuit

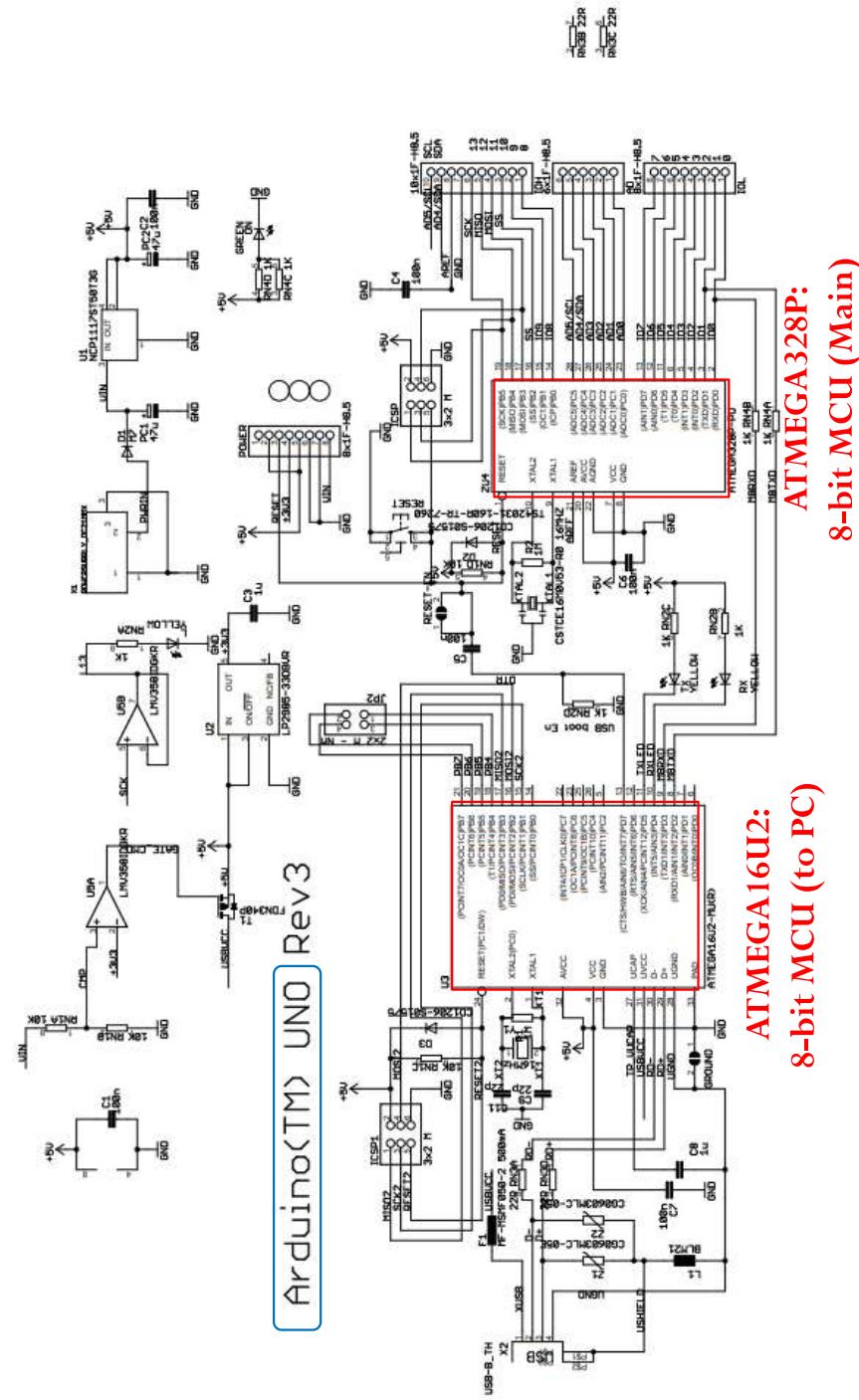
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Program Memory Type	Flash
Program Memory Size (KB)	32
CPU Speed (MIPS/DMIPS)	20
Data EEPROM (bytes)	1024
Timers	2 x 8-bit - 1 x 16-bit
Stand alone PWM	6
Number of ADCs	0
ADC Channels	8
Max ADC Resolution (bits)	10
Number of Comparators	1
Temp. Range Min.	-40
Temp. Range Max.	85
Operation Voltage Max.(V)	5.5

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<https://www.microchip.com/en-us/product/ATmega328P>



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<https://store.arduino.cc/us/arduino-uno-rev3>

**ATMEGA328P:
8-bit MCU (Main)**

MEGA 2560



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作業

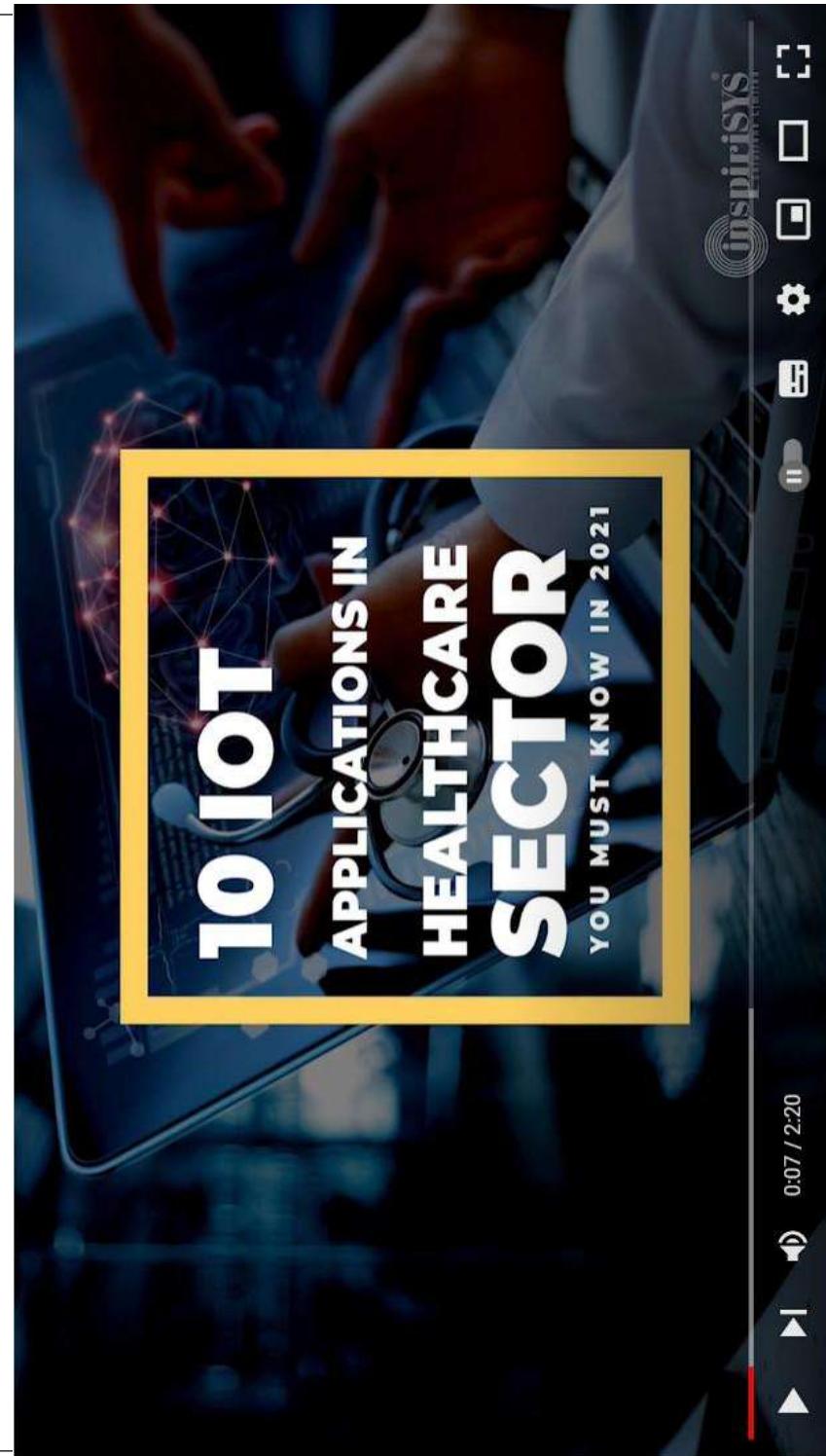
- 仿p.32有關UNO的說明，標記MEGA 2560的腳位用途與晶片型號

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Arduino 程式編輯器

- Lazy Tomato
 - Arduino 開發介面
 - <https://www.youtube.com/watch?v=B4T8hzO0IYc>
 - Arduino 基本指令
 - <https://www.youtube.com/watch?v=Tj8lqbbyuTu4>
 - Arduino 專案開發
 - <https://youtu.be/6oh5jG1e-gQ/>
 - if else 判斷式
 - <https://www.youtube.com/watch?v=hY33-luLYs>

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<https://www.youtube.com/watch?v=KHgqzWBfCK0&t=6s>

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Raspberry Pi

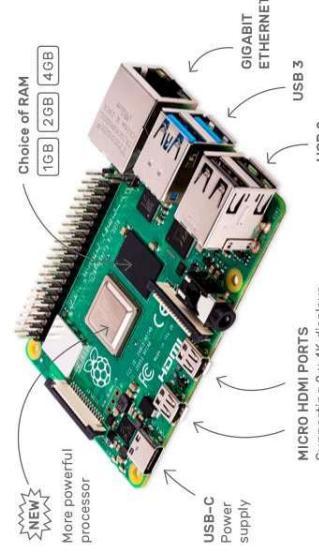
The screenshot shows the official Raspberry Pi website. At the top, there's a navigation bar with links for "Products", "Blog", "Downloads", "Community", "Help", "Forums", "Education", and "Projects". Below the navigation, there are two main sections: one featuring a young man with glasses working on a project, and another featuring an older man with glasses. A central banner for "Raspberry Pi 4" highlights it as a "tiny, dual-display desktop computer". It includes a photo of the Pi 4 Model B board and a "Find out more" button. To the right, there's a section about the mission to put computing and digital making into the hands of people worldwide, with a "Donate" button. At the bottom, there's a link to "www.raspberrypi.org/".

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<http://www.raspberrypi.org/>

The screenshot shows the product page for the Raspberry Pi Model B+. At the top, there's a "Buy now" button. Below it, a large image of the Pi Model B+ board is shown with various components labeled: "More powerful processor", "USB-C Power supply", "MICRO HDMI PORTS Supporting 2 x 4K displays", "GIGABIT ETHERNET", "USB 2", and "USB 3". To the left, there's a sidebar with "Tech specs" and a "Get started" button. The main content area shows a timeline of the Pi's history from Model B to Model B+, with a "Start" button at the end. The footer includes a "Buy a Raspberry Pi 4 Model B+" button and a "raspberrypi.org" link.

Completely upgraded, re-engineered
Faster, more powerful



From \$35

You'll recognise the price along with the basic shape and size, so you can simply drop your new Raspberry Pi into your old projects for an upgrade; and as always, we've kept all our software backwards-compatible, so what you create on a Raspberry Pi 4 will work on any older models you own too.



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In the year of 2006

Promote the study of computer science and related topics, especially at school level, and to put the fun back into learning computing.

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1



Eben Upton, UK

Alan Mycroft, UK

David Braben, UK

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<https://www.youtube.com/watch?v=UCt6d0SCxO4&t=135s>



SoC : BCM2835 改成 BCM2836

Raspberry Pi 2, 2015

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Processor Chipset :	Broadcom BCM2835 ARMv6	Broadcom BCM2836 ARMv7 Quad Core Processor
GPU :	Videocore IV	Videocore IV
Processor Speed :	Single Core @ 700 MHz	QUAD Core @ 900 MHz
RAM :	512 MB SDRAM @ 400 MHz	1GB SDRAM @ 450 MHz
Storage :	microSD	microSD
USB 2.0 :	4x USB Ports	4x USB Ports
Power Draw / Voltage :	1.8A @ 5V	1.8A @ 5V
GPIO :	40 pin	40 pin
Ethernet Port :	Yes	Yes
Dimensions :	85 x 56 x 17mm	85 x 56 x 17mm
Weight :	42g	42g

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SoC : BCM2837

Raspberry Pi 3B, 2016

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SOC :	Broadcom BCM2837 ✓
CPU :	1.2 GHz 64-bit quad-core ARM Cortex-A53 ✓
GPU :	Dual Core VideoCore IV® Multimedia Co-Processor; OpenGL ES 2.0; hardware-accelerated OpenVG; 1080p60 H.264 high-profile decode ✓
記憶體 :	1GB LPDDR2 (和 GPU 共享)
視訊輸出 :	Composite RCA; HDMI
音訊輸出 :	3.5 mm jack; HDMI(1.3 & 1.4)
儲存 :	microSD ✓
USB :	USB 2.0 x 4
Ethernet :	10/100 RJ45 ✓
Wireless :	802.11n ✓
Bluetooth :	Bluetooth 4.1; Bluetooth Low Energy(BLE) ✓
GPIO :	40-pin 2.54 mm (100 mil) expansion header: 2x20 strip
工作電流 :	800 mA
尺寸 :	85mm x 56mm x 17mm
重量 :	42g

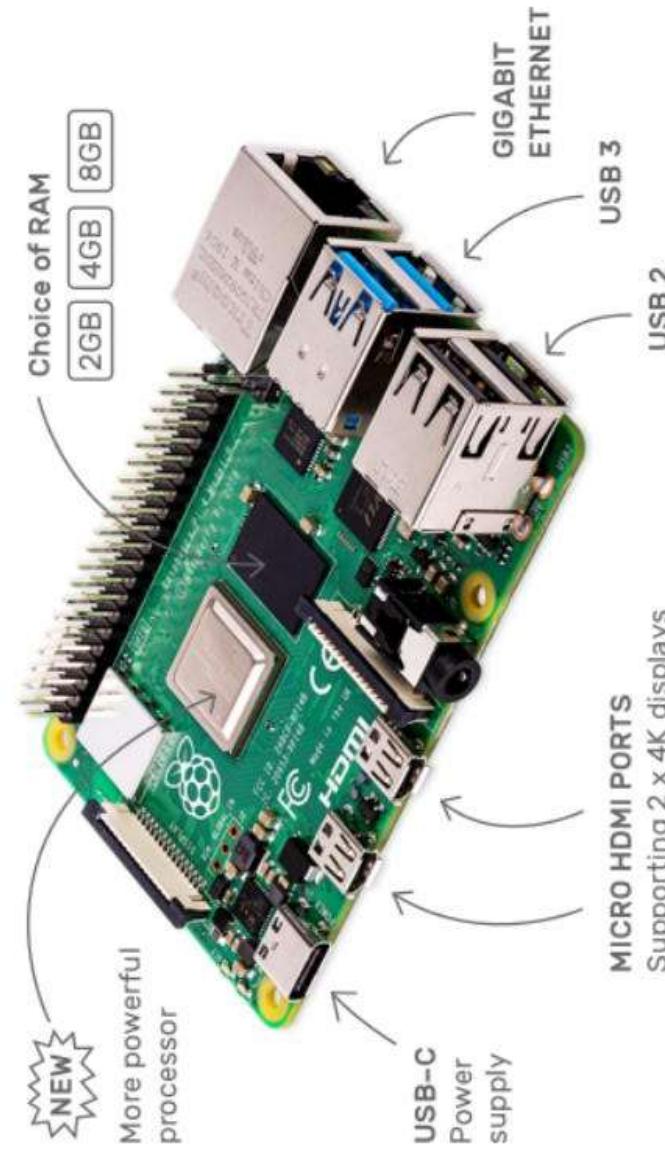
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SoC: BCM2837B0

Raspberry Pi 3B+, 2018

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Raspberry Pi 4, 2019

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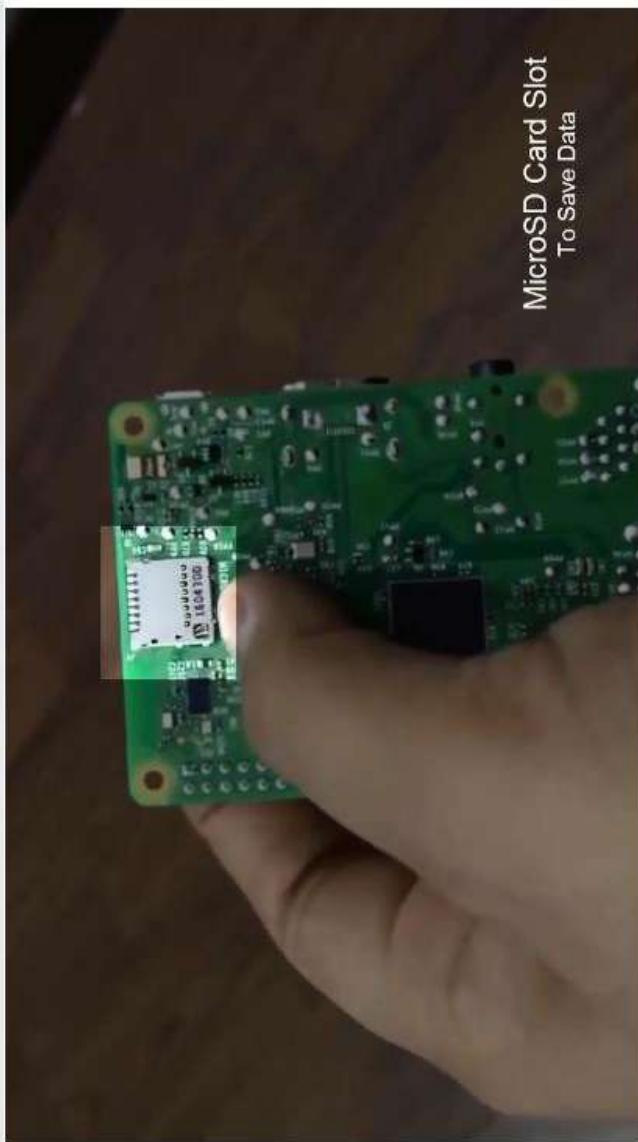
Key Components of Raspberry Pi



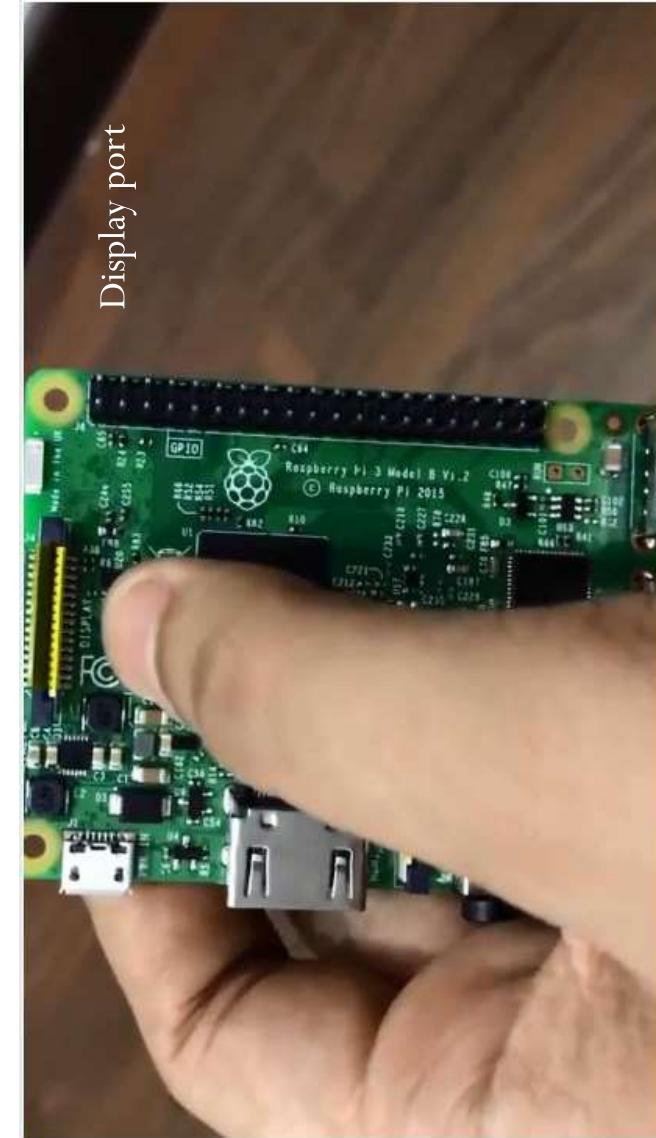
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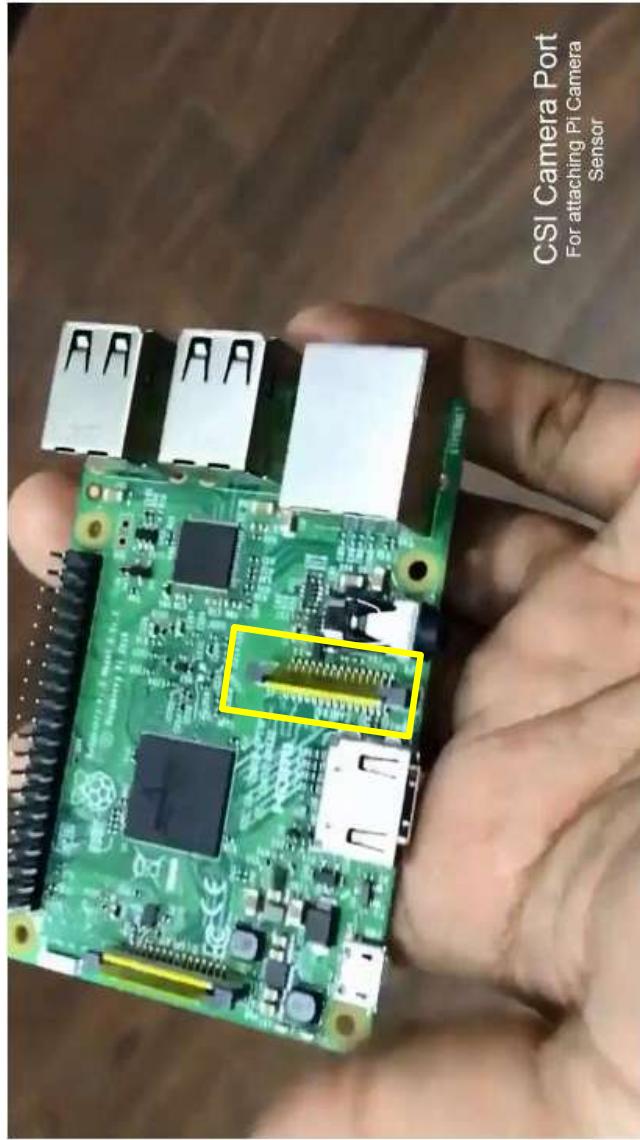
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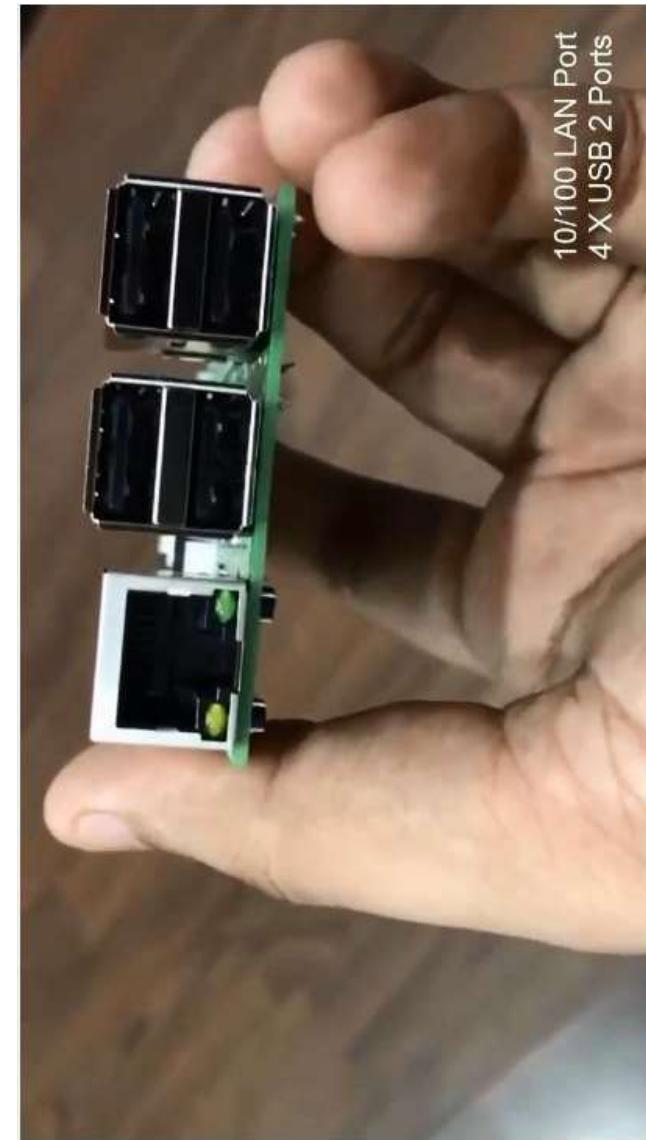
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Raspberry Pi 4 Model B - 8GB

taiwansensor.com.tw

Raspberry Pi 4 Model B - 8GB 樹莓派第 4 代 單板電腦

2019

NT\$2,950 NTS2,695 (未稅)

★★★★★ (目前沒有評價。)

樹莓派最新發布的第四代產品 Raspberry Pi 4 B，性能與樹莓派3B+相比無論是處理器速度，還是多媒體和內存上都有顯著提升。Raspberry Pi 4 B擁有與入門級x86 PC系統相媲美的桌面性能，給您帶來高品質體驗。Raspberry Pi 4 B 具備1.5Ghz運行的64位四核處理器，最高支援以60fps速度刷新的4K解析度的雙顯示屏，高達4GB RAM（可根據型號選擇1GB、2GB、4GB），2.4/5.0 Ghz雙頻無線LAN，藍牙5.0/BLE，千兆乙太網，USB3.0，和PoE功能。

AVAILABILITY: 尚有庫存
貨號: RPI-006545
分類: 樹莓派 RASPBERRY PI

... (Screenshot of the Raspberry Pi desktop environment showing various icons like file manager, browser, and terminal.)

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RPi 3 Model B+		RPi 4 Model B	
Date	2018-03-14	2019-06-24	
Price (US\$)	35	35/45/55	
Chip	BCM2837B0	BCM2711	
CLK	1.4GHz	1.5GHz	
CPU	Cortex-A53 x4	Cortex-A72 x4	
GPU	VideoCore IV	VideoCore VI	
RAM	1GB LPDDR2	1/2/4GB LPDDR4	
USB 2.0	4	2	
USB 3.0	0	2	
HDMI v1.3	1	0	
Composite (TRRS jack)	1	0	
HDMI v2.0 (micro-HDMI)	0	2	
Power connector	micro-USB Type-B	USB Type-C	
Ethernet	1Gbps(300Mbps)	1Gbps	
Wi-Fi	Dual-band 11b/g/n/ac	Dual-band 11b/g/n/ac	
Bluetooth	4.2 LS BLE	5	

<https://makerpro.cc/2019/06/raspberry-pi-4-is-released/>

(Pi 5/8G) 樹莓派 Raspberry Pi 5 Model B / 8GB 開發板 |
SBC | 官方原廠 樹莓派 5 代
| Pi 5B | Pi5B | 8G (英國製
UK 製)



★★★★★ (目前沒有評價。)

NT\$3,000 未稅

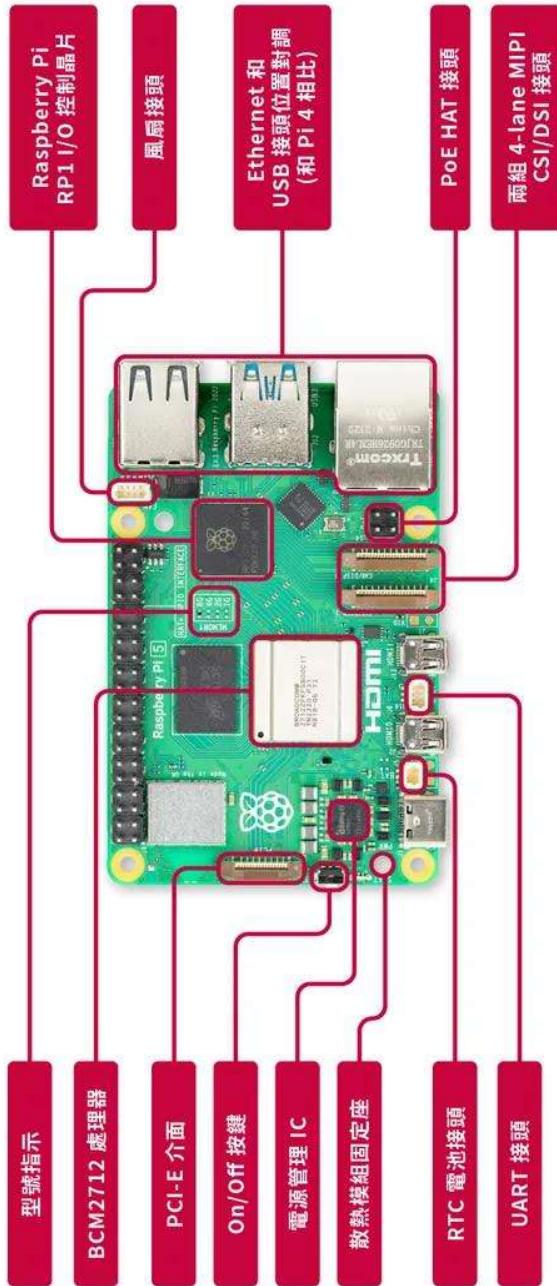
現貨熱賣中！

Raspberry Pi 5 出來了！除了 CPU 速度更快以外，第一顆 Raspberry Pi 自行研發的南橋晶片（Southbridge）RP1 大改 I/O 架構，是第一台採用英國劍橋內部設計的晶片的 Raspberry Pi 電腦。

<https://piepie.com.tw/product/raspberry-pi-5-model-b-8gb>

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The anatomy of Raspberry Pi 5



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樹莓派4		特徵	樹莓派5
Broadcom BCM2711，四核心 Cortex-A72 (ARM v8) 64 位 SOC @ 1.8GHz	整合到CPU中	中央處理器 級緩存	2.4GHz 四核心 64 位元 Arm Cortex-A76 CPU，具有 512KB 二級快取和 2MB 共享三
LPDDR4-3200 SDRAM		影片	VideoCore VII GPU
2.4 GHz 和 5.0 GHz 802.11ac Wi-Fi		記憶體	LPDDR4X-4267 SDRAM
藍牙 5.0 / 藍牙低功耗 (BLE)		無線上網	2.4 GHz 和 5.0 GHz 802.11ac Wi-Fi
Micro SD卡插槽，支援高速		藍牙	藍牙 5.0 / 藍牙低功耗 (BLE)
2 個 USB 3.0 端口，支援同時 5Gbps 操作	2 個 USB 2.0 連接埠	貯存	Micro SD 卡插槽，支援高速SDR104模式
千兆位元以太網 - 支援 PoE+ (需要 PoE+ HAT)		USB 3.0	2 個 USB 3.0 端口，支援同時 5Gbps 操作 (改進)
2 個 micro-HDMI® 連接埠 (最高支援 4kp60)		USB 2.0	2 個 USB 2.0 連接埠 (改進)
2x 2 通道 MIPI 相機/顯示器收發器		乙太網路	千兆位元以太網，支援 PoE+ (需要 PoE+ HAT)
公車		HDMI	2 個 micro-HDMI® 連接埠 (最高支援 4kp60)
5V/3A直流電源		DSI/CSI	2x 4 通道 MIPI 相機/顯示器收發器
Raspberry Pi 標準 40 針接頭		聚氯乙烯	PCIe 2.0 x1 接口，用於快速外設
透過網路連線的時間		力量	5V/5A 直流電源，適用於更多週邊
不適用		通用輸入輸出介面	Raspberry Pi 標準 40 針接頭
		實時時鐘	實時時鐘 (RTC)，由外部電池供電
		開關	板載電源按鈕

<https://www.oursteam.com.tw/view-news.php?id=696>

Table 1: Comparison: Raspberry Pi 4 vs Raspberry Pi 5

Raspberry Pi 4		Raspberry Pi 5	
CPU	Broadcom BCM2711, Cortex-A72 (ARM v8) 64-bit SOC @ 1.8 GHz	Broadcom BCN12712, quad-core Cortex-A76 (ARM v8), 64-bit SOC @ 2.4 GHz	2-3x performance
RAM	1 GB, 2 GB, 4 GB, 8 GB	1 GB, 2 GB, 4 GB, 8 GB	
Connectivity	2.4 GHz and 5.0 GHz 802.11 ac wireless Bluetooth 5.0, BLE Gigabit Ethernet n/a 2x USB 3.0, 2x USB 2.0 ports	2.4 GHz and 5.0 GHz 802.11 ac wireless Bluetooth 5.0, BLE Gigabit Ethernet 1x PCIe 2.0 interface 2x USB 3.0 (5 Gbit/s), 2x USB 2.0 ports	High-speed peripheral interface (for SSDs, etc.)
	Standard 40-pin GPIO header 2x Micro HDMI Ports (up to 4K 60p) 2-lane MIPI DSI, 2-lane MIPI CSI 4-pole stereo audio and composite video	Standard 40-pin GPIO header 2x Micro HDMI ports (up to 4K 60p) 2x 4-lane MIPI (DSI/CSI) n/a	
OS and data storage	microSD card slot	microSD card slot with support for high-speed SDR104 mode	2x interface speed
Input power	5 V DC @ 3 A (via USB-C connector or GPIO)	5 V DC @ 5 A DC (PD-enabled)	New Raspberry Pi power supply
PoE	Via separate PoE HAT	Via (new) separate PoE HAT	Fully PoE 802.3at-compliant
Real-time clock (RTC)	n/a		RTC and RTC battery connector

樹莓派程式編輯

- TBS Learning
 - 認識樹莓派Pi 3B
 - <https://www.youtube.com/watch?v=wj89KJCXr1o>
 - 架設網頁伺服器
 - <https://www.youtube.com/watch?v=0j9QTz6GN5c>
 - 安裝作業系統
 - <https://www.youtube.com/watch?v=jPQIMGz00WWw>
 - <https://www.youtube.com/watch?v=-YKwR51k-Wc>



Arduino ⇔ Raspberry Pi

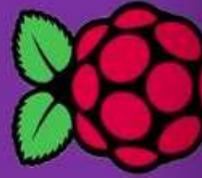
Arduino Uno Single-board Microcontroller

- Control Unit – ATmega328 Microcontroller
- RAM – 2KB
- CPU Architecture – 8bit
- Operating System – No
- Processing Speed – 16MHz
- Power Consumed – 175mW
- I/O Current Drive Strength – 40mA



Raspberry Pi 3B+ Single-board Computer

- Control Unit – Broadcom BCM2837B0 SoC
- RAM – 1GB
- CPU Architecture – 64bit
- Operating System – Yes
- Processing Speed – 1.4GHz
- Power Consumed – 700mW
- I/O Current Drive Strength – 16mA



- Does not support audio and GUIs
- Arduino-specific IDE and Compiler
- Uses "Shields" for extending functionalities
- Best at controlling machines and performing repetitive tasks.



Single-board Computer

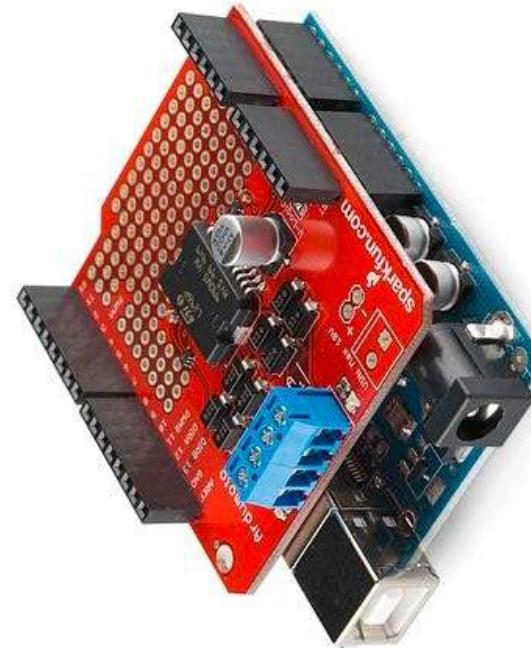
- Supports audio and GUIs
- Wide-range of Operating Software
- Uses "Hats" for extending functionalities
- Best at logical processing of data and communicating with other systems.



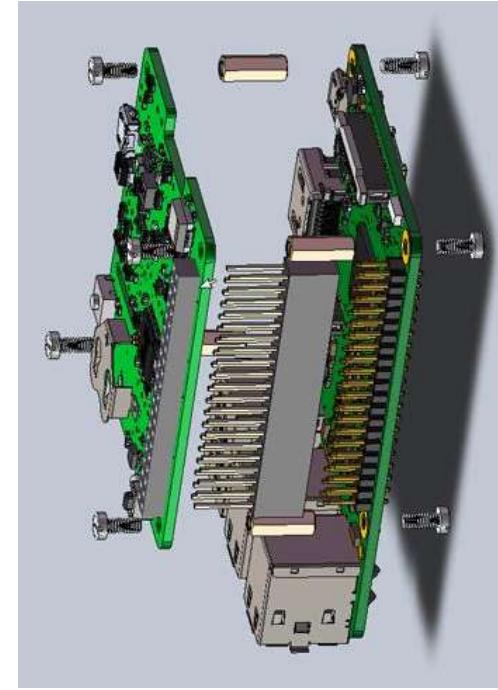
Single-board Computer

<https://www.youtube.com/watch?v=vrQOv40SyDE>

Shield ⇔ HAT



Arduino Shield



Raspberry Pi HAT Hardware Attached on Top

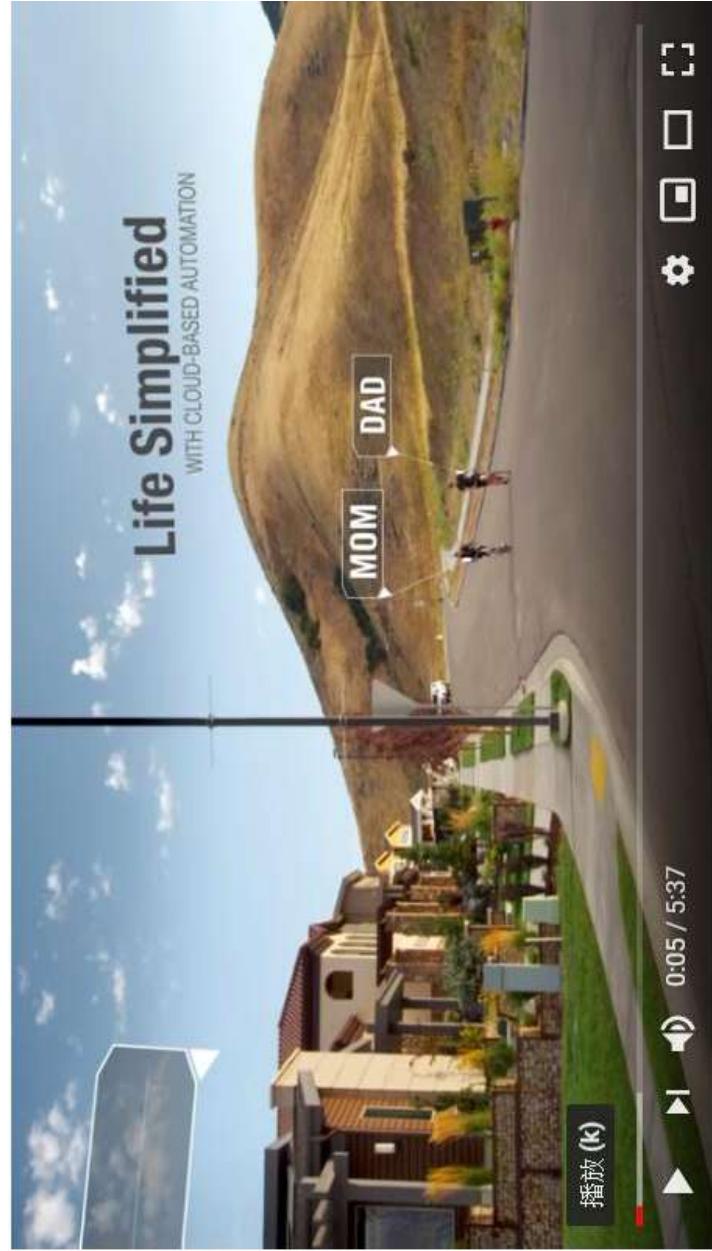
Arduino + Raspberry Pi

- Remote control
 - <https://www.youtube.com/watch?v=IOI7JFR905Q>
- Smart home
 - <https://www.youtube.com/watch?v=0CHkT-Oj0Vk>
- Home automation
 - <https://www.youtube.com/watch?v=7wqY1NFETPg>
- Programming Arduino with Raspberry Pi
 - <https://www.youtube.com/watch?v=mflacE-SPvg>

作業

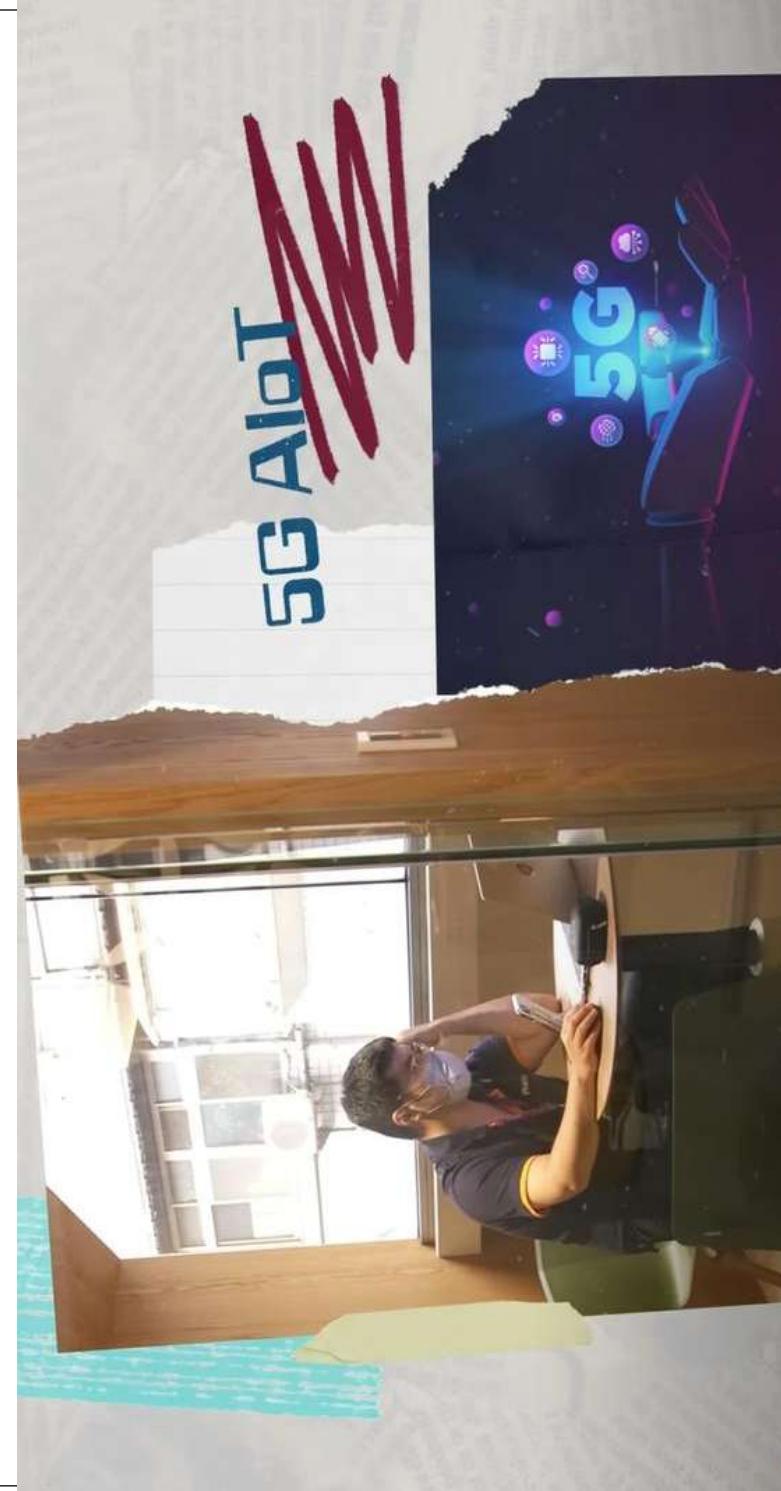
- 觀看 p.75 影片
 - 說明影片中物聯網應用情境
 - 列舉 2 項你覺得最有創意的應用
 - (續前題) 提出你對前述應用可改進的建議

IoT Application



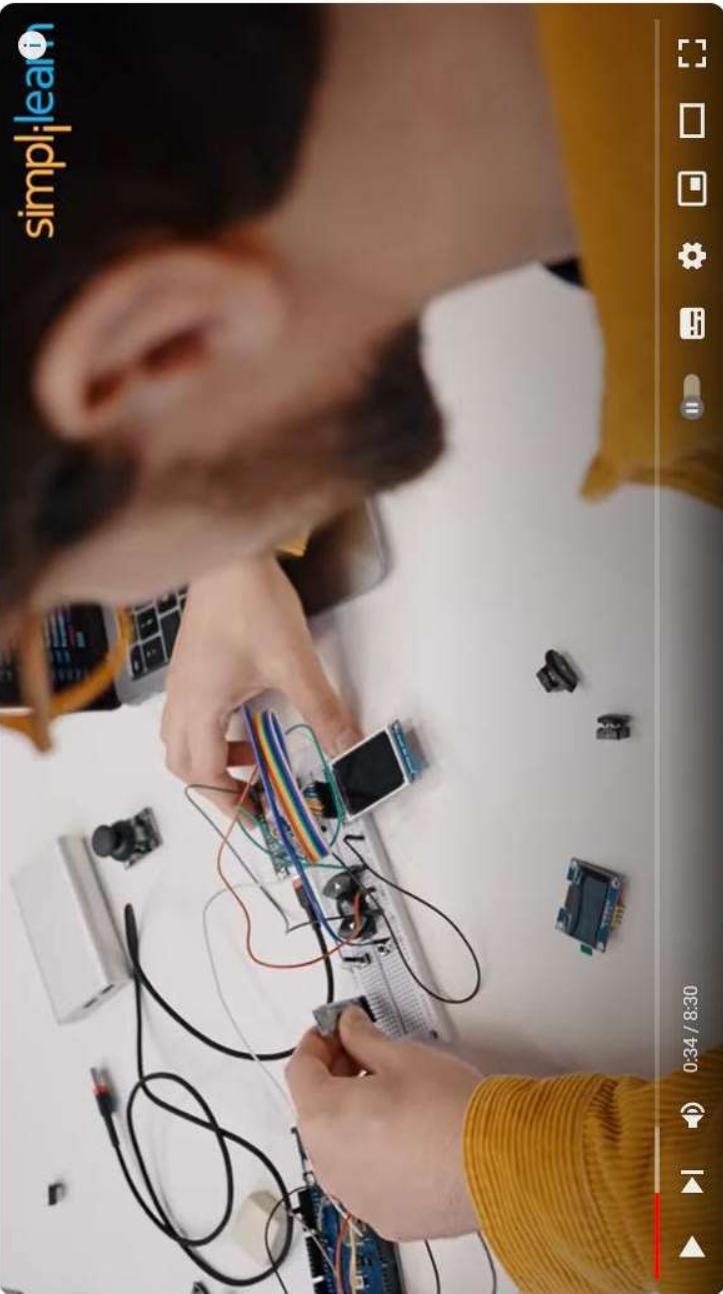
<https://www.youtube.com/watch?v=NjYTzvAVoZo>

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<https://www.youtube.com/watch?v=B-Jw384T2sY&t=141s>



Top 10 IoT Projects 2023 | Smart IoT Projects | Applications Of IoT | Simplilearn

<https://www.youtube.com/watch?v=1GcMAiIMQYU>